THE ORBIT PROPERTIES OF COLLIDING CO-ORBITING BODIES

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It is generally assumed that an ensemble of small bodies located in similar Keplarian orbits will, because of collisions, tend to disperse into more and more dissimilar orbits. For example, it is thought that the asteroids may represent the remnents of a few larger bodies that broke up or failed to fully accrete. Alfvén and Arrhenius (1976), Alfvén (1971), and Baxter and Thompson (1971,1973) and others have challanged this. Alfvén (1971), maintains that for the case where the time between collisions is longer than the orbit period and the collisions are essentially inelastic the orbits and velocities will become more similiar. This gives rise to the concepts of negative diffusion and jet streams. Figure 1 taken from Alfvén and Arrhenius (1976) illustrates the problem: Does the arrow of time lead from figure a. to b. or vice versa.

We propose that this question might be investigated experimentally using the space station. An ensemble of small bodies or particles might be released gently from a central location in a large chamber, much like the breaking of billiard balls (see Figure 2). The particles would then co-orbit and occasionally collide. Their subsequent behavior could be monitored by several video recorders, their linear and angular velocities before and after collisions calculated and their general behavior studied. The experiment might be varied by using particles of varying elasticities (coefficient of restitution), varying masses, and different initial relative velocities. The particles would be colored to make it easy to follow their motion and could be spherical or irregular shaped and smooth or rough. Their size might be approximately that of billiard balls. Materials could be found which would break up on collision and the fate of the collision products followed and the size distribution studied. U.V. lights and gas could be introduced to simulation charging and drag conditions found in space or near a primordial planet.

Figure 3 illustrates the possible relative motion of two bodies released in this fashion. The expected ultimate configuration for this simple case is that the bodies line up again at rest in the center of the chamber.

The proposed experiment requires a large spherical or cylindrical chamber about 14 feet (4.66 m) in diameter with three cameras looking into the chamber along three orthogonal axes. The particles will be in free orbits about the center of the chamber, therefore, the vertical or horizontal motion of the chamber, due to loss of altitude from drag or thrusting must not exceed 3 feet (1 m) in 10 orbits (~15 hours). The experiment may need to run for as long as 50 orbits. It requires only initiation and periodic checks by the crew to insure the cameras are operating. Power is required to operate the cameras and lights, 50 watts with a 10% duty cycle, and to initiate release of the particles, 5 watts for 5 seconds.

This experiment could yield results of fundamental importance for theories of the origin of the planets, the asteroids, comets and probably ring systems.

References:

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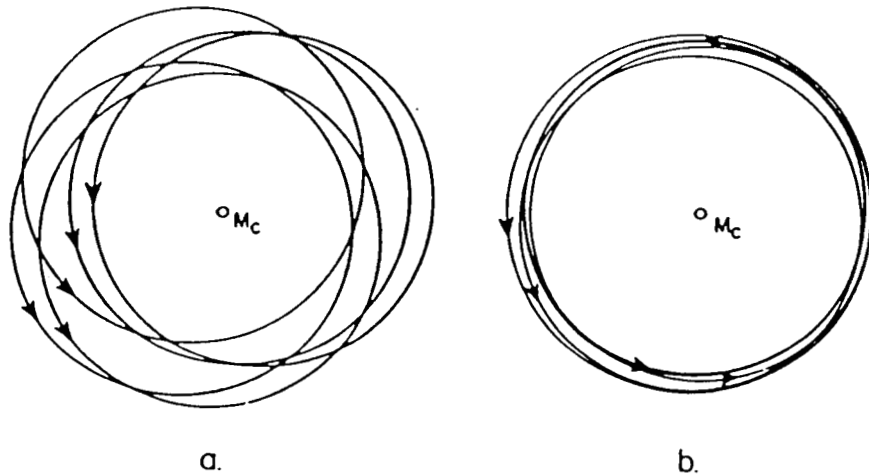
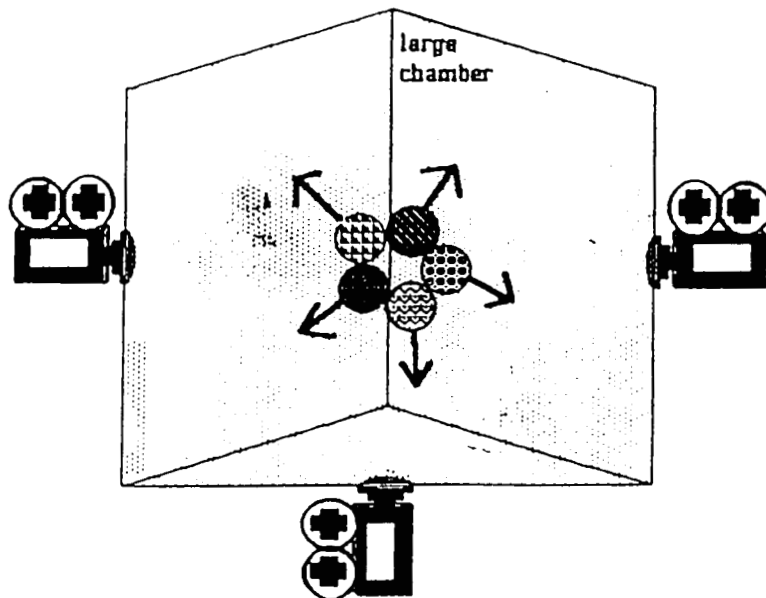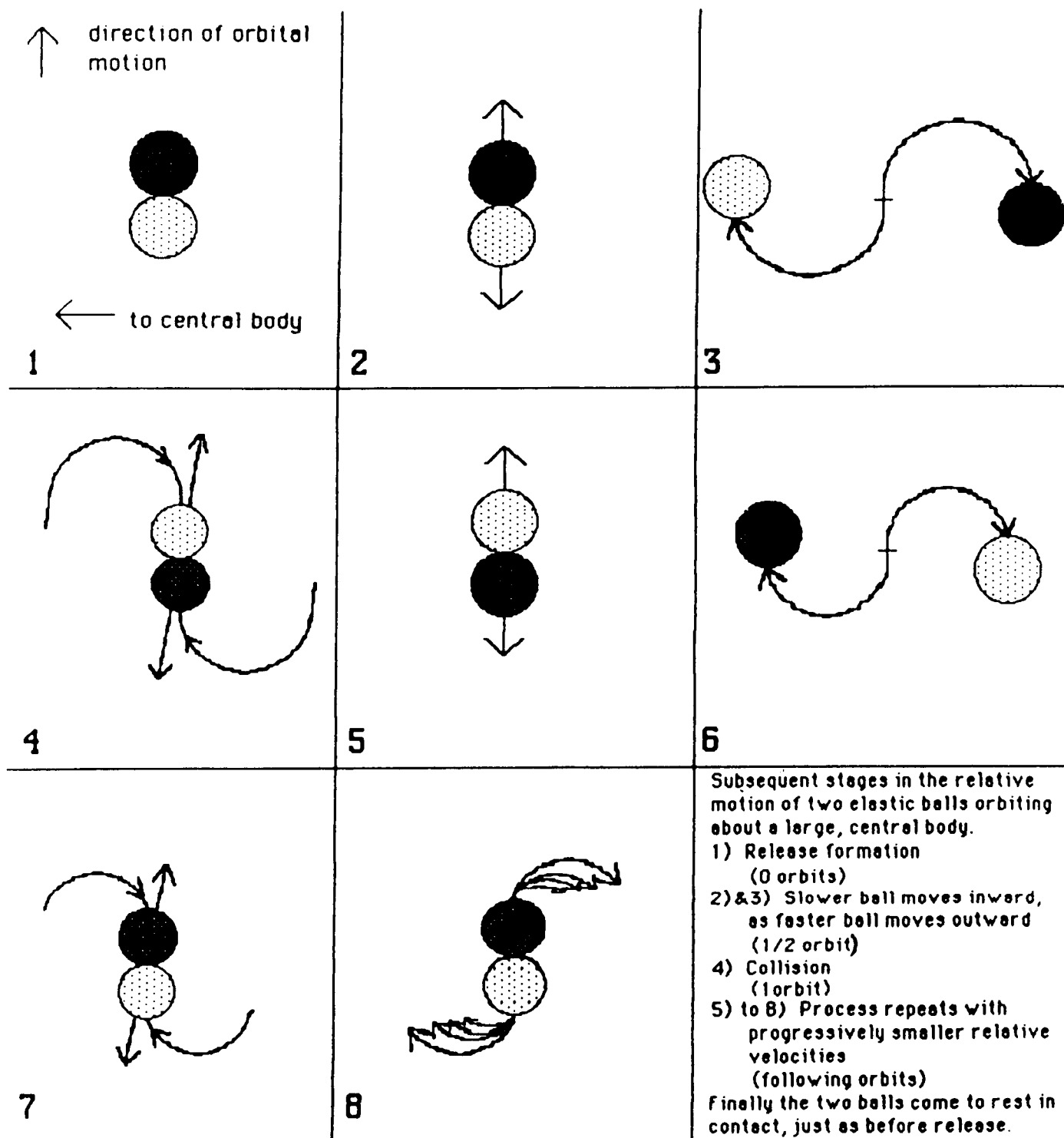a.   b.

Figure 1

large chamber

Figure 2

direction of orbital motion

← to central body

1

2

3

4

5

6

7

8

Subsequent stages in the relative motion of two elastic balls orbiting about a large, central body.
1) Release formation
   (0 orbits)
2)&3) Slower ball moves inward, as faster ball moves outward
   (1/2 orbit)
4) Collision
   (1 orbit)
5) to 8) Process repeats with progressively smaller relative velocities
   (following orbits)
Finally the two balls come to rest in contact, just as before release.

Figure 3